These percentages may need to be adjusted to eliminate scum formation and promote natural mixing by the gas produced within the mass. If scum forms, a small increase in percent solids may be desirable. This increase may be limited by pumping characteristics and should seldom go above 12 percent solids.

(iii) Determine effective digester volume—A hydraulic detention time of 20 days is suggested. This time appears to be about optimum for efficient biogas production. The daily digester inflow in cubic feet per day can be determined using equation 10–24.

$$DMI = \frac{TMTS \times 100}{DDSFC \times 62.4} \qquad [10\text{–}24]$$

where:
DMI = Daily manure inflow, ft³
TMTS = Total manure total solids production, lb ~~ft³~~/day (per Boyd email 1/15/03)
DDSFC = Desired digester input total solids concentration, %

The necessary digester volume in cubic feet can be determined using equation 10–25.

$$DEV = DMI \times 20 \qquad [10\text{–}25]$$

where:
DEV = Digester effective volume, ft³
20 = Recommended detention time, days

(iv) Select digester dimensions—Optimum dimensions of the liquid part of the digester volume have not been established. The digester should be longer than it is wide to allow raw manure to enter one end and digested slurry to be withdrawn at the other. An effectively operating digester has much mixing by heat convection and gas bubbles. True plug flow will not occur.

Sufficient depth should be provided to preclude excessive delay at start-up because of the oxygen interchange at the surface. A combination of width equal to about two times the depth and length equal to about four times the depth is a realistic approach. Other proportions of width and length should work equally well. For the purpose of discussion assume:

$$H = \left(\frac{DEV}{8}\right)^{0.33}$$
$$WI = 2 \times H$$
$$L = 4 \times H$$

where:
H = height, ft
WI = width, ft
L = length, ft

Dimensions should be adjusted to round numbers to fit the site and provide economical construction.

(v) Estimate biogas production—Biogas production is dependent on VS destruction within the digester. An efficient digester that has a 20-day retention should reduce VS by 50 percent. Some research indicates a reduction of 55 percent of VS in swine manure and 60 to 65 percent in poultry manure. Biogas production from poultry manure may vary significantly from the estimates presented below. Animals fed a high roughage ration produce less biogas than those fed a high concentrate ration. Estimated VS reductions are:

Dairy and beef 50%
Swine 55%
Poultry 60%

Figure 10–47 Gas agitation in an anaerobic digester